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ABSTRACT

A rationale for the teaching of thinking and problem-solving skills is outlined, and the definition of and design for teaching such skills are discussed. Developing the ability of students to think has surfaced in recent years as one of the major purposes of American education. Problem solving has been described as a major type of thinking strategy. Vocational education programs offer a unique curriculum that is rich in potential problems for study and investigation. Major steps in problem solving include: (1) recognition of the problem; (2) representation or clarification of the problem; (3) development of a solution plan; (4) execution of the plan; and (5) evaluation of the solution. Problem-solving teaching stimulates interest, develops thinking ability, and helps students make decisions. This teaching method is a comprehensive instructional approach that directly addresses the major principles of effective teaching and learning. When effectively used, problem-solving teaching boosts student motivation. Effective problem solving requires a democratic approach to teaching and learning. Simultaneously, the importance of individual students and the development of their thinking skills and academic foundations are clearly recognized. (TJH)

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Using Problem-Solving Teaching:

Theoretical and Philosophical Considerations*

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> Thinking has not been honored generally in the schools, nor has the total enterprise been too imaginative. Textbooks that pile fact upon fact, while neglecting . . . the problems to which they are relevant . . . have dominated the scene. Education has not been notably successful as a liberating, intellectual enterprise (Hullfish, 1961, p. 9).

Although many would agree with the above conclusion boldly stated by Hullfish, Beyer (1987) suggests that improved student thinking has been a goal of American education for decades. The development of thinking ability reflects one of the Seven Cardinal Principles which have provided a foundation for American education in the 20th century--namely, command of fundamental processes (Duck, 1985). There is no doubt that developing students' thinking abilities has surfaced as one of the most important goals of public education in the 1980s. Historically, educators have focused their attention on subject matter outcomes, believing that reasoning and problem solving abilities would naturally develop as students accumulated knowledge and developed manipulative skills. However, Beyer (1987) and other educational reformists contend that good thinking can only be developed through conscious, focused efforts. Skillful thinking requires " . . . deliberate, continuing instruction, guidance, and practice in order to develop to its fullest potential" (Beyer, 1987, p. 1).

Why Thinking/Problem-Solving Skills Should Be Taught

Public education in America has a twofold purpose: to impart knowledge (including performance knowledge and skill), and to teach cognitive skills. Bracey (1983) argued that

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while reading, writing, and arithmetic are important areas of study, the truly basic skills include listening and speaking, thinking, and reasoning. "One of the most important cognitive skills is no doubt problem-solving ability" (Frederiksen, 1984, p. 363). Major thinking operations include evaluation and analysis, critical thinking, problem solving, synthesis, application, and decision making (Beyer, 1987). Problem solving is considered a key type of discovery learning (Gagné, 1966).

Educators and psychologists generally agree that one's ability to transfer learning from one situation to another is enhanced by focusing on general principles and concepts. This ability to transfer knowledge and skills learned to other situations is the implicit goal of any educational endeavor (Bender, 1986). Problem solving, as a type of discovery learning, has been shown to increase transfer of learning (Andre, 1986). Students are destined to encounter problems in and out of school that will require careful thought and action. Particularly after graduation, students will not be able to turn to their teachers for answers to these life situations. As Beyer (1987) reminds us, thinking skills remain constant, while facts and information become obsolete.

Personal freedom in a democratic society also allows personal choice, decision making, and responsibility. The ability to think and solve problems is essential in a society such as ours. Hullfish (1961) contends that the lack of reflective thought in our public schools contradicts the democratic principles upon which our country is based. Public education in America should seek to develop independent-minded individuals who possess intellectual autonomy, defined by Crunkilton (1984) as the ability to conceptualize problems and effectively work toward their solution. By using a problem-based teaching approach, students assume significant responsibility for their learning and grow toward this long term goal. John Dewey, considered by most to be the pioneer of problem-solving teaching, described the aim of education as "growth leading to further growth" (Skilbeck, 1970). In

Dewey's view, using problem-based teaching, or reflective thinking as he called it, is the best approach to achieving this goal.

Intelligence is defined in part as one's ability to effectively solve problems (Sternberg, 1986). Displaying an unlimited mental bank of facts and figures is always impressive, but the real, significant challenge lies in creatively and effectively responding to problems as they are encountered. Problem-solving activity helps develop patient thinking, which is also a characteristic of intelligent thinkers (Beyer, 1987; Slife & Cook, 1986; Whimbey, 1980). Experiencing success in problem solving can do much to enhance the self-esteem of people, particularly young people. And, an increase in thinking ability will lead to an increase in problem-solving ability. But can thinking in general, and problem solving in particular, as a type of cognitive thinking, be taught? Cognitive psychologists are confident that generalized problem-solving skills can be taught (Frederiksen, 1984).

Wassermann (1987) concluded from her review of research that a curriculum which emphasizes thinking leads to improved student thinking skills and greater achievement in academic knowledge and skills. She concluded that practice in thinking skills produces more skillful thinking over time. According to Beyer (1987), the teaching of thinking should occur throughout the school curriculum in all grade levels. This steady emphasis on thinking skills allows for long term improvement in thinking ability and increased transfer of thinking skills. Research has shown that increased academic performance results when students are taught the cognitive operations of the thinking process. Like other areas of learning, students must practice thinking processes in order to become skillful thinkers. Students are more motivated to learn problem solving when it is needed to accomplish tasks in the subject matter area. The empirical and philosophical evidence clearly suggests that thinking skills, and more specifically problem-solving ability, can be effectively taught and learned in the classroom.

Designing the Teaching/Learning Process to Reflect Problem-Solving Teaching

A widely accepted model for the study of classroom teaching was developed by Mitzel (Dunkin and Biddle, 1974). In this model, shown in Figure 1, Mitzel classified all variables in the teaching/learning process as either context (environmental), presage (teacher), process (classroom), or product (outcome) variables. Upon careful consideration of Mitzel's model, the many points in the teaching/learning process that can potentially accommodate or align with problem-solving teaching become evident.

Among the presage variables, the background experiences of the teacher, both in education and in family life, can influence the teacher's tendency to use problem-based teaching. The model also suggests that preservice and inservice teacher education programs influence teacher behavior in the classroom. Thus, if teachers are taught to effectively and confidently use problem-solving teaching as a part of their preparation for teaching, then an inquiry/discovery mode of student learning will be more likely to prevail. Of course, a major dimension of this preparation is the development of a supportive attitude and philosophy toward this type of teaching and learning.

Student behavior in the classroom is most influenced by teacher behavior and classroom climate. In short, teachers create or discourage a classroom atmosphere that invites creative thinking and problem solving on the part of students. Student behavior is also affected in large part by past experiences, current knowledge, and motivation. These traits are certainly alterable and can be influenced in a positive way by teacher efforts. As educators, we like to believe that what we do with our students in the classroom has a bearing on their academic achievement and overall growth and development. The Mitzel model suggests that giving direct attention to problem-solving skills in the teaching/learning process at least holds the potential for immediate and perhaps long term improvement in

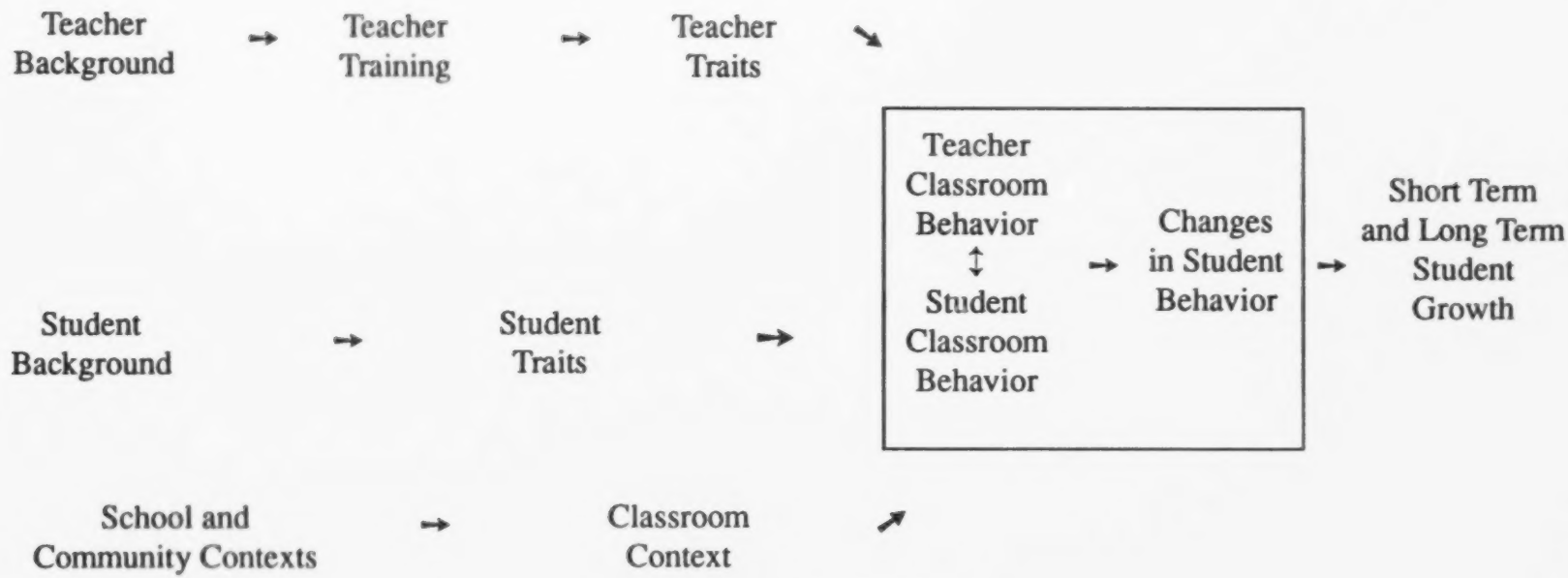

Figure 1. A model for the study of classroom teaching (Mitzel in Dunkin and Biddle, 1974).

problem-solving ability. This, of course, assumes, as the research generally suggests, that skillful thinking and problem solving are skills that can be taught in the classroom.

Defining Problem-Solving Teaching

While problem solving, critical thinking, decision making, and creative thinking are sometimes used synonymously, Beyer (1987) is quick to point out that they are not the same. However, they all involve higher order thinking skills and do contain some of the same thinking operations. "Thinking . . . is the mental process by which students make sense out of experience" (Beyer, 1987, p. 16). Problem solving is accurately described as analogous to Dewey's notion of reflective thinking and the familiar scientific method of inquiry. A problem may be defined as a life situation in which a person wants to respond but is unsure of the course of action needed. Problem solving generally defined, then, is the mental and behavioral activity used in dealing with problems (Andre, 1986). Reflection, or problem solving, occurs when one is unable to succeed with a desired action (Hullfish, 1961).

Problem solving is a type of cognitive thinking which consists of sequential, subordinate operations, such as analyzing and selecting. The major steps in problem solving are (1) recognize the problem, (2) represent (clarify) the problem, (3) devise a solution plan, (4) execute the plan, and (5) evaluate the solution (Beyer, 1987). As will be discussed in the next section of this paper, this description of problem solving is very similar to the learning process and problem-solving teaching as described by Newcomb, McCracken, and Warmbrod (1986). Problem-solving teaching is an approach to planning and teaching whereby instructional content is based upon problems encountered by students when performing tasks or making decisions in the real world. Students use inquiry techniques under the leadership of the teacher to identify, test, and evaluate solutions to the problems under consideration.

Attributes of Problem-Solving Teaching

As students learn in a problem-solving format, they identify questions to answer or, in essence, break the problem under study into subcomponents. Problem solving, more than any other approach to teaching, addresses the important dimensions of effective teaching and learning. Discussion of the following principles of teaching and learning illustrates the ability of problem-solving teaching to address these recognized dimensions of effective teaching.

1. *Genuine interest is generated through activity, curiosity, ownership, perceived relevance, thinking, suspense, and a sense of progress.* When problem-solving teaching is used, students are active learners physically and/or mentally, and they determine the direction of the learning process through their own questions and inquiry. The challenge of effectively solving the problem creates interest, which builds as students realize that they can succeed in problem solving and acquire the identified knowledge and skills. As Hullfish (1961) stated, teaching and learning should be adventurous.

2. *Students must be motivated to learn.* Problem-solving teaching begins with an interest approach, which contains a provocative situation and is designed by the teacher to create a "felt need" on the part of students. The "need to know" feeling is developed by following Socratic techniques whereby students are led to realize the discrepancy between what they know and what they need to know in order to accomplish a desired task. Thinking skills are best learned when students develop a "felt need" in a particular subject area (Beyer, 1987). Motivation is greatest when students' needs, interests, and abilities are addressed. When using problem-solving teaching, students identify the

questions to answer, which reflect their characteristics and interests. Students perceive learning activities as useful and relevant, which also increases motivation. Motivation increases when students assist in planning learning activities (Newcomb, McCracken, & Warmbrod, 1986). Students tend to work harder and learn more when they have helped to determine learning tasks (Schmuck, Chester, & Lippitt, 1966). Research has consistently shown that achievement and retention increase with an increase in motivation (Henson, 1980).

3. *Students must be active in the learning process.* Active student learning, as opposed to passive student roles in learning, can be based in mental and/or physical activity. Problem solving, as a major type of thinking strategy, most certainly activates mental processes in learning. Lancelot (1944, p. 143) stated "a first law of all good teaching is that pupils must be kept thinking. For where there is no thinking, there is no learning, and where there is no learning, there is no teaching." Lancelot further suggested that getting students to think is accomplished by keeping problems or thought questions before them. Sadler and Whimbey (1985) claimed that the best way to teach thinking skills is to have students raise questions about what they have read or problems they are attempting to solve. In problem-solving teaching the technical content of the area of study is determined through student questions in response to problem situations.

4. *Students think as they confront puzzling or challenging situations.* Basing teaching and learning activities on problems encountered by students takes advantage of the natural human response to think and attempt to solve such situations. Thus, problem-solving teaching demands student thinking, which

stimulates imagination, a key ingredient in creative problem solving. Problem solving, as a type of discovery learning, increases intellectual effort and helps students become confident in their ability to think creatively about intellectual problems (Kagan, 1966).

5. *Learning is improved when students seek solutions and explanations as opposed to receiving instruction in the subject area.* Thus, problem solving and student inquiry techniques are most effective in promoting achievement (Newcomb, McCracken, & Warmbrod, 1986). Problem-solving teaching clearly places students in a discovery or inquiry mode of learning. They become more active in the learning process, they sense a degree of ownership and responsibility for their learning, and they practice and improve thinking skills as they participate in learning activities. For these and other reasons, students become more motivated to learn and more successful in the learning process.

Summary

Developing the ability of students to think has surfaced in recent years as one of the major purposes of American education. While recognized as an important outcome of education for decades, only recently have direct efforts to develop skillful thinking been considered as a significant component of education. Many educators, as well as cognitive psychologists, now agree that thinking ability can be developed and improved through practice. In addition, leaders in this field of study firmly believe that the teaching of thinking must be a visible element in every classroom and in every grade level, suggesting that skillful thinking is not discipline or subject matter specific.

Problem solving has been described as a major type of thinking strategy. Lancelot (1944) proposed that using a problem-solving process in teaching is the best way to develop general thinking ability. Lancelot further stated that using problem-solving teaching is teaching for permanent outcomes, whereby knowledge becomes functional in the lives of students. Vocational education programs offer a unique curriculum that is rich in potential problems for study and investigation. Problem-solving teaching stimulates interest, develops thinking ability, and helps students make decisions. It makes instruction meaningful and relevant and develops attitudes of questioning, comparison, and doubt (Phipps & Osborne, 1988).

When the use of problem solving and student inquiry approaches to teaching are encouraged, teachers sometimes shun these strategies, stating that they must "cover" a specified amount of "material" in the day's lesson. Clearly, the focus of instruction for these teachers is wrong. As Dewald-Zink and Wallace (1983, p. 216) explained, " . . . basic (academic) skills and knowledge are of little use if they cannot be applied to solving problems." Beyer (1987) stated that the goal of education is to make students proficient enough so they can learn and act responsibly and effectively on their own. This goal implies that the process of learning is much more lasting than the content of learning.

Problem-solving teaching, as described by these symposium presenters, is a comprehensive instructional approach that directly addresses the major principles of effective teaching and learning. When effectively used, problem-solving teaching boosts student motivation, which is positively correlated with student achievement. As students experience success in the classroom and improve their ability to think and solve problems, then their self-confidence is improved. When students are active in the learning process by seeking solutions to problems, then learning becomes more of a challenge than a chore. Similarly, " . . . serious attention to teaching thinking . . . can lead to the kind of classroom interplay

and quest for knowledge that makes teaching at least as intellectually challenging and stimulating as any other profession" (Beyer, 1987, p. 4). Teachers who effectively use problem solving teaching create the type of classroom atmosphere that encourages objective discussion and focused pursuit of relevant questions. However, ". . . in some classrooms ideas are crushed by the relentless march of fact" (Hullfish, 1961, p. 27). Effective problem solving requires a democratic, team approach to teaching and learning. At the same time, the importance of individual students and the development of their thinking skills and academic foundations is clearly recognized. Classrooms should allow students the freedom to apply their individual traits and values to real life problems (Hullfish, 1961). In problem-solving teaching students play a key role in determining the agenda for learning. After all, soon these students will be setting their own short term and long term agendas and working to effectively carry them out. Shouldn't we be consciously and directly helping them develop their thinking and problem-solving abilities now, so they can live and work with confidence and success in the future?

> There is more to teaching than serving as a conveyor belt that transmits the materials of a book to the "minds" of students (Hullfish, 1961, p. 22).

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